Identification of a Local Region in the Striate Cortex of Rat Brain Specialized in Complex Visuomotor Functions

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Extirpation of a local region led to irreversible loss of the corresponding function. A local region of the striate cortex specialized in visuomotor functions was identified in rat brain.

Key Words: *experimental pathology of the CNS; brain; localization of function*

Identification and detailed examination of anatomic loci with distinct functional properties, which combine systemic integration of sensory stimuli and the formation of motor efferentation within a combined adaptive response are of considerable importance for studying the integrative functions of the brain [1,6]. Today, some authors report that the brain cortex of higher animals represents a network structure with excessive associations, while others believe that the cortex includes highly specialized and strictly localized structures and mechanisms.

Famous American neuropsychologist K. S. Lashley was the first who assumed that rat cortex includes some zones of functional specificity responsible for discrimination of complex visual stimuli (DCVS) [8]. These cortical zones result from geometrical superposition of various extirpations with different localizations and areas of injury (Fig. 1, *a*) [4]. Here we determined anatomical localization and the size of local regions in rat occipital cortex critical for DCVS and studied the ability of animals for repeated (postoperative) learning.

MATERIALS AND METHODS

Experiments were performed on 120 male Wistar rats weighing 125-150 g. Since not all animals were suitable for our experiments [5], they were selected (on average 1 of 20 rats) as described previously [9]. Experimental rats were trained DCVS by the method of Lashley [4]. The animal should jump from the start platform through one of the holes closed with cards with images (visual stimuli, VS to the platform beyond the screen. VS were white figures on black background. These cards were presented in pairs. The card with nonreinforced VS was unmovable, while the card with reinforced VS was placed in such a way that the rat can fold it up, appeared on the platform, and received reinforcement. Learning was continued to attaining of 12/13 correct responses. Bilateral extirpation of brain cortical regions was performed under Nembutal anesthesia (50 mg/kg), and the rats were tested for DCVS 7 days postoperation [7]. Visual acuity of operated rats was assessed by the formation of image discrimination (ID) response with painful electrical stimulation [2]. VS were the same as described by Lashley. Learning was continued to attaining of 9/10 correct responses. Postoperative locomotor coordination was examined using the same experimental model as during training DCVS. Intracardiac perfusion with 10% formaldehyde (pH 7.3-7.5) was then performed. The size and localization of extirpated cortical regions were analyzed on frontal brain sections stained by the Nissl method.

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RESULTS

Postoperative examination of DCVS showed that field *c* extirpations (Fig. 1, *a*) [8] destroyed this skill due to impairment of visual acuity estimated by the test of defensive ID response formation. Extirpation of field *b* had no considerable effect on animal behavior, while extirpation of a cortical region located 0.5 mm medi-

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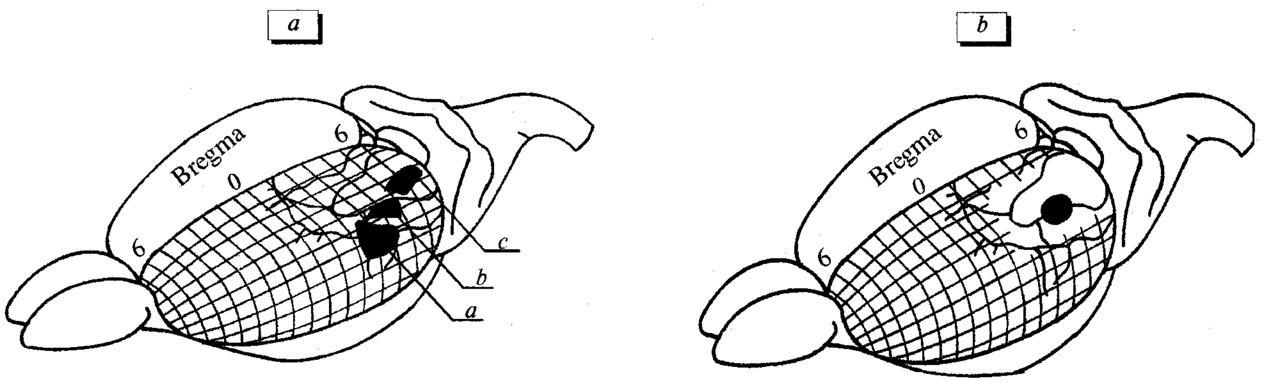

Fig. 1. Rat brain regions involved in perception of complex visual stimuli. Areas described by K. S. Lashley (*a*); localization of the critical locus determined by analyzing functional specificity (*b*); brain cortical regions (*a-c*, see Materials and Methods).

ally to this field led to irreversible loss of DCVS. The ability for fine visual differentiation (test for ID conditioning) and the motor component of DCVS (brightness discrimination test) preserved in operated animals. Thus, the area of functional specificity for this motor visual skill (Lashley's area) lies 5.3 mm caudally to the bregma at the boundary between fields Oc1 and Oc2.1 (Fig. 1, *b*) [10]. This determines the corresponding neuroanatomical division of this zone to the lateral and medial parts and its peculiar cytoarchitectonic (combination of the visual projection area and secondary polysensory visual area) (Fig. 2). Thus, despite poorly developed associative regions and diffuse distribution of afferent fibers in rat brain, complex visuomotor functions are strictly localized. The presence of this zone in rats and specific consequences of its extirpation allow us to draw the analogy to the existence of highly specialized associative cortical regions in human brain appeared during evolution: the frontal Broca's area and temporal Wernicke's area. In both cases, alteration of highly specialized brain functions is not accompanied by impairment of specific sensory functions. Hence, this strictly localized region specialized in visuomotor integration in the striate cortex in rats with relatively imperfect vision is of special interest.

Thus, this local region (Lashley's area) is a convenient physiological model for studying systemic mechanisms of structural and functional changes in the brain cortex during complex conditioning under normal conditions and in CNS diseases.

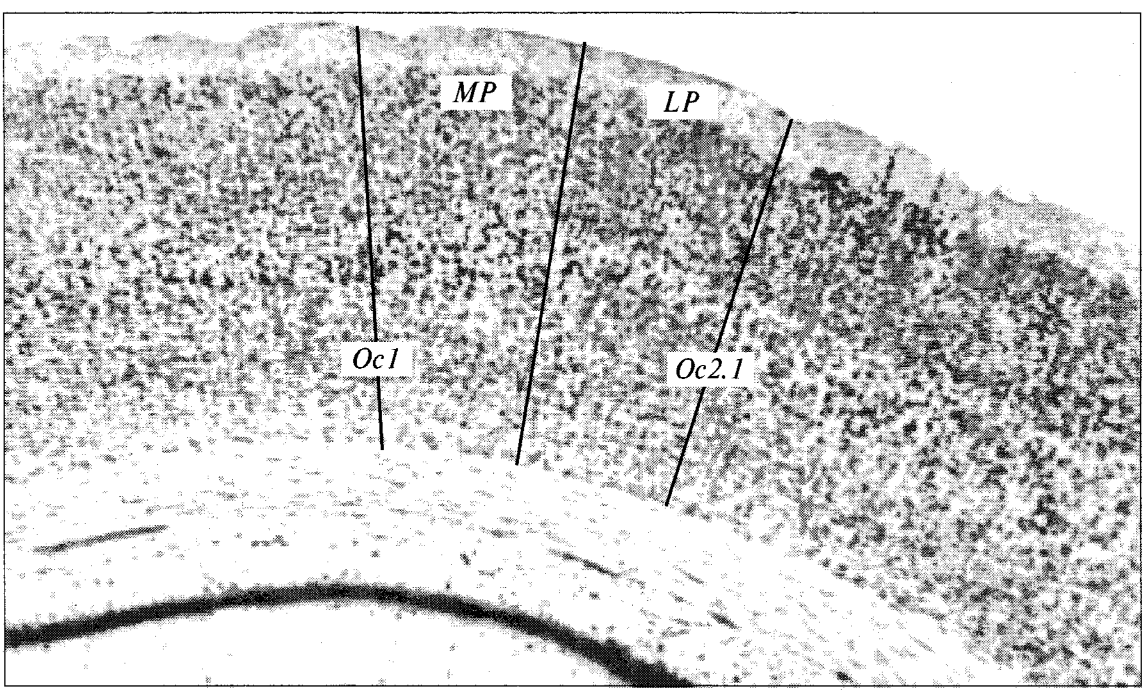

Fig. 2. Frontal slice of the rat brain visual cortex stained by the Nissl method (×40). Primary (Oc1) and secondary (Oc2) visual areas; medial (MP) and lateral (LP) parts of the zone of functional specificity.

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